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Comparison of Three Food Consumption Estimation Procedures

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ABSTRACT

Three food demand estimation procedures were compared to find which best measures the structure of food demand. These procedures were Seemingly Unrelated Regression, Block Additive, and Ordinary Least Squares. The focus was on food commodity substitution. The comparison of results was made on the basis of commodity demand and net change in calories consumed as estimated by each procedure. Each procedure projects a similar pattern of commodity demand and net caloric intake change. Overall, the Seemingly Unrelated Regression procedure provides the most reasonable and consistent results.

Keywords: Food demand, food consumption, consumer demand, nutrient intake, household survey, demand parameter, estimation, elasticity estimation.

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PREFACE

High prices and inadequate incomes are often blamed for inadequate diets in developing countries, yet the impact of price and income changes on the market demand for food in such countries is little understood. The few studies available have focused on one or a few large aggregate commodity groups. Comprehensive studies of food demand that consider specific commodities are rare and largely confined to highly developed economies. An exception would be Indonesia with analysis done by Alderman and Timmer, and by Dixon (appropriate citations appear in the Reference section).

Poor diets in developing countries are widespread and persist despite substantial agricultural development efforts by many Governments. Lack of information on food demand and consumption behavior of specific consumer groups is an important contributing factor. Information that does exist is usually derived from national aggregate data and thus limited to national totals or averages and consideration of one, or at most a few, large aggregates of commodities. It is thus impossible to analyze the potential impact of food policy decisions on the consumption of specific commodities by specific groups within the population.

Underlying the limited food demand information has been the lack of appropriate data. Food demand analysis has traditionally relied on time series data. However, the amount of such data needed to estimate the structure of food demand is much greater than is available in most developing countries. Many countries have recently undertaken large-scale national household food consumption and expenditure surveys. These surveys contain the detailed information needed to permit highly disaggregated analysis of food demand.

Research on the structure of food demand in developing countries has been undertaken by the Agricultural Development Branch, International Economics Division, Economic Research Service, U.S. Department of Agriculture. The goal is to generate knowledge for use in programming U.S. food aid and development assistance, and improving the accuracy of global food demand projections and the associated implications for U.S. agricultural exports.

The objective of the current research was to develop a procedure to analyze food demand as a comprehensive system. An additional requirement is that the analysis be sufficiently disaggregated so that information is generated regarding the consumption of specific foods by specific segments of the population. Only with detailed information at this level is it possible to make adequate *a priori* analysis of the potential impact on demand of food policy changes, plan agricultural projects to fill specific food needs, or project import needs of specific food commodities.

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INTRODUCTION

This paper, comparing estimates of changes in food consumption derived from three econometric procedures, attempts to determine which provides more useful results. This work is a continuation of, and uses the same data as, that reported by Chieruzzi, Morgan, and Yetley. Both reports are an outgrowth of efforts to estimate the structure of food demand in developing countries using household survey data.

An important objective in the overall project is to investigate the impact of food and agricultural policy alternatives on food consumption. In this paper, the objective is to compare the results of three procedures on estimated food consumption. Since the level of food consumption is one measure of human welfare, it is important to maintain within the analysis procedure as much detail as possible on foods consumed so that one can properly assess demand changes within consumer groups. Thus, it is important to derive information on the impact of a price change in any one or combination of food on the consumption of all foods in each consumer group since the same nutrients, in varying amounts, can be obtained from several foods. This, in turn, requires the estimation of a complete matrix of own- and cross-price plus income demand elasticities for each consumer group. These matrices represent the structure of food demand within the identified consumer groups.

The data used in this study were taken from a Sri Lankan survey conducted in four successive 3-month rounds from November 1969 to October 1970 (see References). The country was first stratified into three sectors: urban, rural, and estate representing 16.4, 71.8, and 11.8 percent of the total households, respectively. Then, a two-stage stratification was performed. Census blocks of about 100 households were designed as first-stage units and households within census blocks were designated as second-stage units. Included in this survey are household consumption and expenditure data for over 100 food items, expenditure data for nonfood goods and services, and socioeconomic and demographic characteristics of the household.

An interviewer visited each household for 7 consecutive days to obtain information on food and beverage consumption and expenditures. If goods were consumed out of stocks but purchased during a previous period, the actual quantities consumed were recorded and the expenditures derived using current prices. Likewise, if quantities in excess of weekly consumption were purchased, the quantities purchased and corresponding expenditures were prorated to a weekly consumption basis.

Raw household consumption data were converted to pound equivalents for each of 118 food items identified in the survey. Consumption quantities were aggregated into 12 food categories and converted to a monthly household per capita basis. Within each household, implicit unit prices for each food category were derived from aggregated expenditure and quantity data in order to estimate quantity-dependent demand equations.

The data were partitioned into 10 subsamples, representing five monthly household income ranges in rural and urban areas. These subsamples were specified for several reasons. First, specifying the demand system for each of the 10 subsamples enables comparisons of demand behavior over a wide range of household socioeconomic and demographic characteristics. Second, the subsamples conform to the survey partitioning scheme which permits a comparison of the consumption levels (by food category and subsample category) derived to the corresponding values reported by the Sri Lanka Department of Census and Statistics for all households surveyed. This comparison served as an important factor in assessing the representativeness of the data in the 10 subsamples. The 12 food categories were used in each of the 10 consumer groups to estimate the complete matrix of elasticities.

Each matrix was estimated using three econometric procedures. This produced 30 complete demand matrices, each containing well over 100 elasticity values. Detailed investigation of this many values in the process of comparing the three estimation procedures is clearly an overwhelming task. A method to summarize the results was needed.

METHOD OF COMPARING ECONOMETRIC PROCEDURES

The task of comparing results across procedures was made more manageable by introducing a price change as the economic stimuli to the demand system. Changes in consumption and substitution among food groups were then traced within each consumer group.1/ In this manner, the overall effect of the own- and cross-price elasticities as estimated by each procedure may be directly compared. Further insight into the validity of the three procedures may be gained by comparing the calculated results against criteria derived from the nutritional sciences and known consumption habits and preferences. These criteria are

1/ This price change could be the result of market forces or a change in government food price policy in those countries where food prices are controlled.

particularly useful with respect to the validity of the cross elasticity estimates as manifested by substitution among foods. These comparisons, together with an investigation of the own-price and expenditure elasticities estimates, provides a basis for assessing the utility of the three procedures.

The Econometric Procedures Used

Three econometric procedures were used to estimate the structure of food demand as reflected by a complete matrix of demand elasticities. The procedures used were: (1) Seemingly Unrelated Regressions (SUR), (2) Block Additive (BA), and (3) Ordinary Least Squares (OLS).2/ The econometric points directly relevant to the results and interpretations presented here are briefly discussed to facilitate comparison of the procedures.

The SUR procedure makes the fewest consumer behavior assumptions. Within the theoretical restrictions, consumers may substitute freely among foods. In contrast, the BA procedure allows substitution only within the same food block.3/ Hence, to the extent consumers do substitute between food blocks, the estimates produced by this technique will be biased. A partially offsetting advantage of the BA procedure is that it estimates fewer parameters and can therefore be used with smaller sample sizes. The OLS procedure makes no *a priori* assumptions on consumer behavior. But, because the parameters are estimated on a commodity-by-commodity basis, the theoretical restrictions on the demand system can only be applied after the parameters have been initially obtained.4/

Basis of Comparison

A comparison of the estimated food consumption changes with previous works is of little use because of the paucity of comparable published work. However, it is possible to develop a basis for comparison from economic theory and biological requirements. This basis is then used to gain insight into the adequacy of the three procedures in capturing the structure of food demand.

2/ Details of the econometric and empirical estimation techniques may be found in Chieruzzi, Morgan, and Yetley.

3/ In this analysis, these blocks are: Block I (rice, other cereals and bakery products, food consumed away from home), Block II (spices, vegetables, fish, other meats, milk and eggs), Block III (fruits and nuts, sugar and confectionary, cooking oils, fats, and oil-bearing nuts), and Block IV (alcohol, tobacco, and chewing nuts, nonalcoholic beverages). These blocks were delineated by a Sri Lankan agricultural economist experienced in food marketing. No attempt has been made to determine if other food commodity groupings would provide more valid blocks.

4/ The manner in which the post-estimate restrictions are applied closely follows the procedure used by Brandow.

The theory of consumer economics states that demand for a normal good will increase with increased income and decrease as price increases. This translates into positive income (expenditure) elasticities and negative own-price elasticities, both of which are anticipated to become smaller in absolute value as income (expenditure) levels increase.

Own-Price Elasticity Estimates: The elasticity estimates were compared against these criteria and positive (incorrect) own-price estimates were obtained in 5 instances from SUR, 5 from BA, and 8 using the OLS procedure, out of a total of 72 estimated values. Of these, one was statistically significant in SUR, none for BA, and two for OLS (see app. A). With only one exception, these incorrect signs were obtained only in the upper income consumer groups.5/ Further, these positive own-price estimates were obtained in three foods: rice (BA and OLS estimates), food consumed away from home (all three procedures), and cooking oil (all three procedures). Of these foods, rice is by far the most important, both in terms of proportion of the food budget and in caloric contribution to the diet. For this staple, the SUR procedure yields no "incorrect" estimates, while BA has one and OLS has two such estimates. On the basis of this comparison, the SUR procedure appears to be preferable since it provides the fewest incorrect estimates and none which are statistically significant in the major food categories (see table 1).

Table 1--A summary of incorrect own-price elasticity values obtained from three estimation procedures

Sign	SUR	BA	OLS
Incorrect signs for rice estimates	0	1	2
Total incorrect signs	5	5	8
Statistically significant and incorrect signs	1	0	2

Source: Appendix A.

Income Elasticity Estimates: A comparison of the income (expenditure) elasticities provides little basis for selecting among the procedures. Each procedure yields estimates that have the expected positive sign in every instance. All estimates are statistically significant, except for three OLS estimates in the upper income groups for foods with small budget proportions. The magnitudes of the expenditure elasticity estimates are reasonable and of comparable magnitude across the three procedures (see app. B).

5/ The income strata, based upon household monthly expenditures, are: strata 1, under 200 Rupees (Rs); strata 2, 200-399 RS; strata 3, 400-599 Rs; strata 4, 600-799 Rs; strata 5, over 800 Rs. The average exchange rate during 1969-71 was $1.00 U.S. = 5.95 Rs.

Each procedure provides own-price and expenditure elasticity estimates where the magnitude of these values tends toward zero as income levels increase. However, these trends are not smooth or monotonic (see the food group estimates in app. A and app. B). There is a tendency for the estimated values in urban income groups 2 and 3 and rural income groups 3 and 4 to be numerically larger than the trend would indicate. There is also a reversal of the expected trend--that is, the elasticity values are larger--in the expenditure elasticity estimates for other grains, cereal, and bakery products (CER) and for meats, milk, and eggs (ANI) for urban consumers. There is also a suggestion of a reverse trend for own-price estimates for the animal products food group (ANI) among these same consumers.6/ Otherwise, the estimated values from each procedure do tend to behave as theory suggests. For this reason, there is little basis for selecting one versus another of the procedures.

Cross-Price Elasticity Estimates: The comparison of the cross-price elasticity estimates requires a different approach. Not only are there many more values but there is no generally agreed statistical or economic criteria to apply to individual estimates. There is little *a priori* reason or research background on which to anticipate a positive or negative algebraic sign for a particular cross-price elasticity value. Expectations for these values must be derived from knowledge of the cultural food habits or nutritional considerations. Nor are there particularly strong reasons to expect specific values to be statistically significant since substitution among foods is influenced by cultural tastes and preferences and market availability.

Net Impact on Consumption: There are, however, some expected results for changes in consumption for lower versus higher income groups, given a particular economic stimuli to the food demand system. For example, for a price increase in staple foods, the expectation is for all income groups to decrease consumption of that food. This follows from the negative own-price elasticity. However, the substitution pattern would be expected to be different between low- and high-income consumers and possibly between rural and urban residents. In the lower income groups, where diets are barely adaquate, the expectation is that decreased consumption of a staple will lead to substitution with other foods in an effort to maintain the highest possible energy (caloric) intake level consistent with budgetary limitations. This implies two additional points: (1)

6/ There are possible explanations for these unexpectedly large elasticity values. It is conceivable that the expenditure elasticity values reflect intrafood group substitution; for example, cereal to bakery goods. For the own-price elasticity values, the consumers in urban income groups 2 and 3 and rural income groups 3 and 4, may be demanding better quality (higher price per unit) and also consuming more (higher quantity purchased) such that the percentage quantity increase is larger than the percentage unit price increase.

substitution will occur between the staple and other foods with high caloric density having similar or cheaper costs per calorie and (2) substitution consistent with (1) above suggests a decrease, or at least no increase, in the consumption of economically superior foods which are more costly sources of calories.

In contrast, the substitution pattern of high-income consumers need not follow that of the poor. The reasoning is that they are not constrained by either economic or physical energy considerations. For this reason, it is difficult to anticipate the substitutions, if any, made by these consumers. However, it is unlikely that the substitution effect would result in increased consumption of economically superior goods. These expectations indicate a need to investigate the net impact of a price change on food consumption and suggest the important role of the cross-price elasticity values.

The net consumption impact is used to compare the three econometric procedures and is obtained by converting the changes in quantities demanded from each estimation procedure to nutritional equivalents.7/ This allows a direct comparison of the net consumption effect as estimated by the SUR, BA, and OLS procedures, and reduces the need to look at individual cross-elasticity values.

The specification of the estimation equation used in this report is based on work reported by Chieruzzi, Morgan, and Yetley. They used the log-log transformation to estimate the food demand system represented by

$$[q_{i,k}]_{(m)} = [e_{ij}]\ P_{i,k(m)} + [\gamma_{i,k}]Y_{k(m)} \quad (1)$$

where $[q_{i,k(m)}]$ is a vector of quantities per capita per day of food commodities purchased by household k in consumer group m, $[P_{i,k(m)}]$ is the price vector of prices paid per unit by household k in consumer group m, $Y_{k(m)}$ is the expenditure of household k_m, $[e_{ij}]$ is the matrix of own- and cross-price parameter estimates, and $\gamma_{i,k}$ is a vector of expenditure parameters associated with household k. Using the log-log transformation, the parameter estimates are the own-price, cross-price, and expenditure elasticities.

To calculate quantity changes, equation 1 is transformed into

$$[\Delta q_{i,k}]_{(m)} = [e_{ij}]_{(m)}[\Delta P_{i,k}] + [\gamma_{i,k}]\ Y_{k(m)} \quad (2)$$

7/ The conversion to nutritional equivalents, calories and grams protein, was made by multiplying estimated changes in quantity demanded by a constant representing the caloric density per unit weight. All estimation work was done using quantity per capita per day, with all quantities converted to pounds. The nutrient contribution of individual foods to its food group is based on average proportional weight to the total for the food group within each consumer group.

where the Δ operator denotes percentage change. Since our focus is on the impact of the cross elasticities, and hence the substitution effect contained within the $[e_{ij}]$ matrix, the expenditure change is assumed to equal zero, that is, $\Delta Y_{k(m)} = 0$. Because separate parameter estimates were made for each consumer group, m, the $[e_{ij}]$ matrix is unique to each consumer group and is denoted as $[e_{ij}]_{(m)}$. Thus, to estimate the impact of a given price change on the demand for food commodity i in consumer group m, equation 2 becomes

$$[\Delta q_i] = [e_{ij}]_m [\Delta P_i] \qquad (3)$$

The percentage quantity change obtained for each commodity is converted back to original units and then to nutritional (calorie) equivalents to obtain the consumption impact.8/ Since the $[e_{ij}]_m$ matricies were estimated by each of the three procedures, that is, SUR, BA, and OLS, the substitution impact on net consumption can be compared across the procedures.

A COMPARISON OF THE NET CHANGE IN CALORIC INTAKE

As expected, the evidence strongly suggests that a 5-percent increase in the market price of rice will result in a net decrease in caloric intake (see table 2). This holds for all consumer groups, both rural and urban, for the SUR procedure. For the BA procedure, these estimates were all negative except for rural income group 5. The OLS estimates were similarly negative with two exceptions, rural income groups 4 and 5.

A detailed look at the BA and OLS estimates of a positive change in net caloric intake indicates these values derive from the positive own-price elasticity estimates, as opposed to food substitution. These "incorrect" own-price estimates were discussed earlier. This positive net caloric change merely reinforces the earlier discussion regarding the validity of these positive own-price elasticity values.

8/ The conversion from original units to percentage and back to the original units was done to avoid having the same absolute price change applied to all markets. Assuming that different costs per unit are faced by different consumer groups, the conversion to percentages facilitates the assumption that all markets change by the same percentage rather than the same absolute figure.

But which of the procedures provides the best estimate? There is relatively little evidence in table 2 from which to draw an inference, except for the unexpected positive values found in rural income group 4 and 5 under the BA and OLS procedures. The question, then, involves the adequacy of these estimates. Figures 1 and 2, which are graphic representations of table 2 data, provide additional information on this question.

Note first the similarity in the pattern of the estimated changes in calories per capita per day from each of the three procedures in both rural and urban income groups. In fact, in the urban sector, not only the pattern but the magnitude of the estimated net caloric changes are similar. For rural consumers, the pattern and magnitude of the estimates is similar for the procedures for income groups 1, 2, and 3, but diverge for income groups 4 and 5. The reason for this divergence, as previously noted, appears to be the positive BA and OLS own-price elasticity estimates in these two consumer groups.

The overall pattern for SUR estimates of net caloric change indicates an initial drop, then a recovery, for both rural and urban consumers as income levels increase. In the urban sector, the BA and OLS estimates are quite close to the SUR values in all income groups and essentially maintain their relative ranking except in income group 5. Except for this latter group, and very close values for SUR and BA in income group 1, the least change in caloric intake is attributed to SUR estimates and the largest change to OLS, with the BA estimates lying intermediate to the SUR and OLS values.

As can be seen in figure 2, the relative ranking of the estimated values from the procedures across income levels in the rural sector are not as stable as was found for urban consumers. There is also a much more pronounced change in the magnitude of the estimates from one income group to the next, even though the general pattern of the estimates is similar both among the procedures and in comparison to urban consumers. For example, rural income group 2 experienced the largest decrease in daily per capita intake. In the urban areas, group 3 had the largest decline, but with a smaller magnitude. All three procedures show the same pattern in this regard.

The similarity in pattern of the estimated changes in caloric intake suggests the estimation procedures are robust. That is, the procedures are capturing the same general structure of food demand. The exception, as already noted, is in the upper rural income groups. However, the overall comparability and similarity in the pattern of the estimates supports the use of the estimation procedures. The fact that the estimated values are reasonable in magnitude supports the use of household food consumption and expenditure surveys as appropriate data sources for estimating the structure of food demand.

Because of these similarities, it is necessary to look further for evidence of a "best" estimation procedure. The magnitude of

Table 2--A comparison of the estimated net demand change in calories per capita per day resulting from a 5-percent increase in the price of rice

Consumer income group	Estimation procedure		
	Seemingly Unrelated Regressions (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)
		Calories	
Rural:			
1	-12.1	-24.8	-10.9
2	-41.7	-46.0	-56.8
3	-12.2	-26.9	-21.9
4	-8.3	-26.8	5.6
5	-8.9	38.4	21.6
Urban:			
1	-1.7	-13.6	-0.2
2	-2.0	-14.6	-5.1
3	-5.6	-19.2	-14.9
4	-3.4	-7.4	-7.0
5	-6.5	-5.2	-10.9

Figure 1: Urban income group: Changes in calories per capita per day as a result of a 5-percent increase in the price of rice

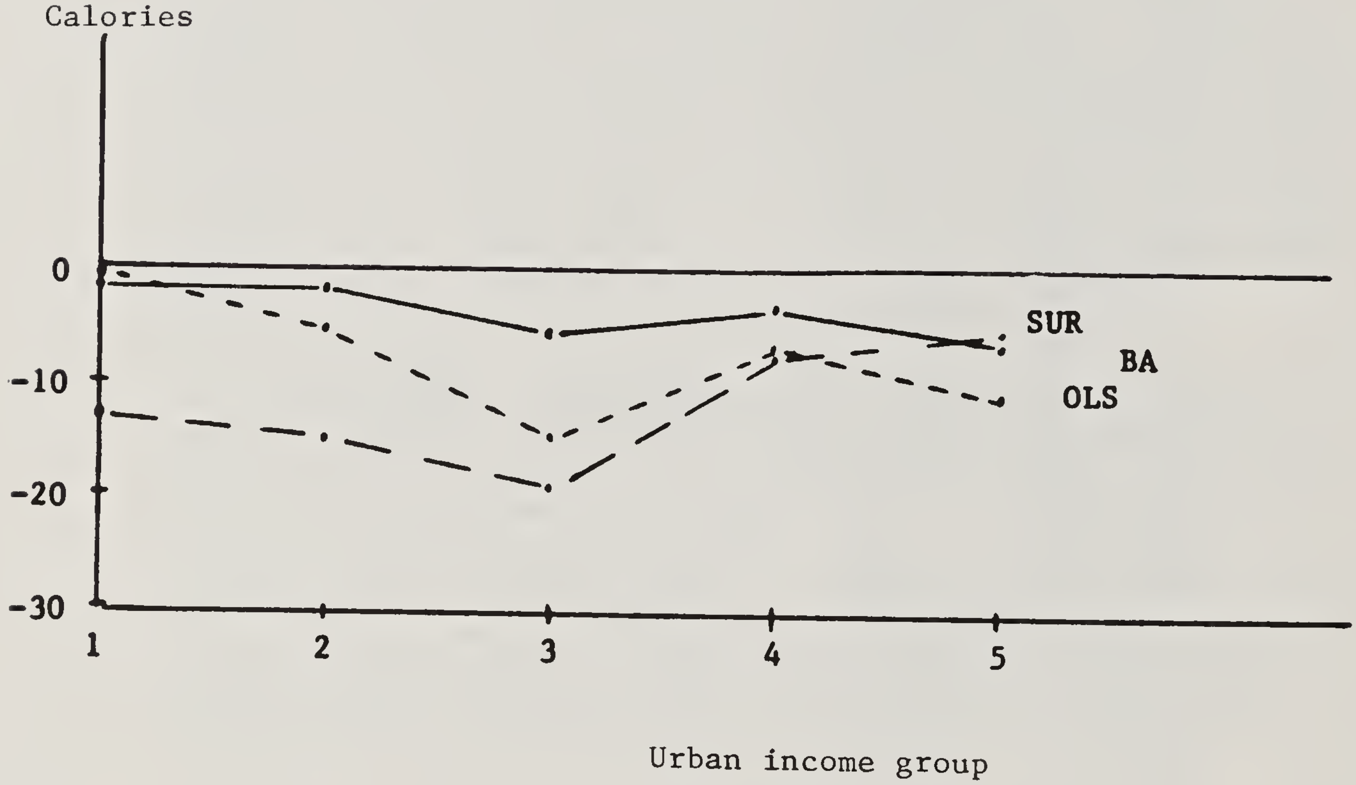
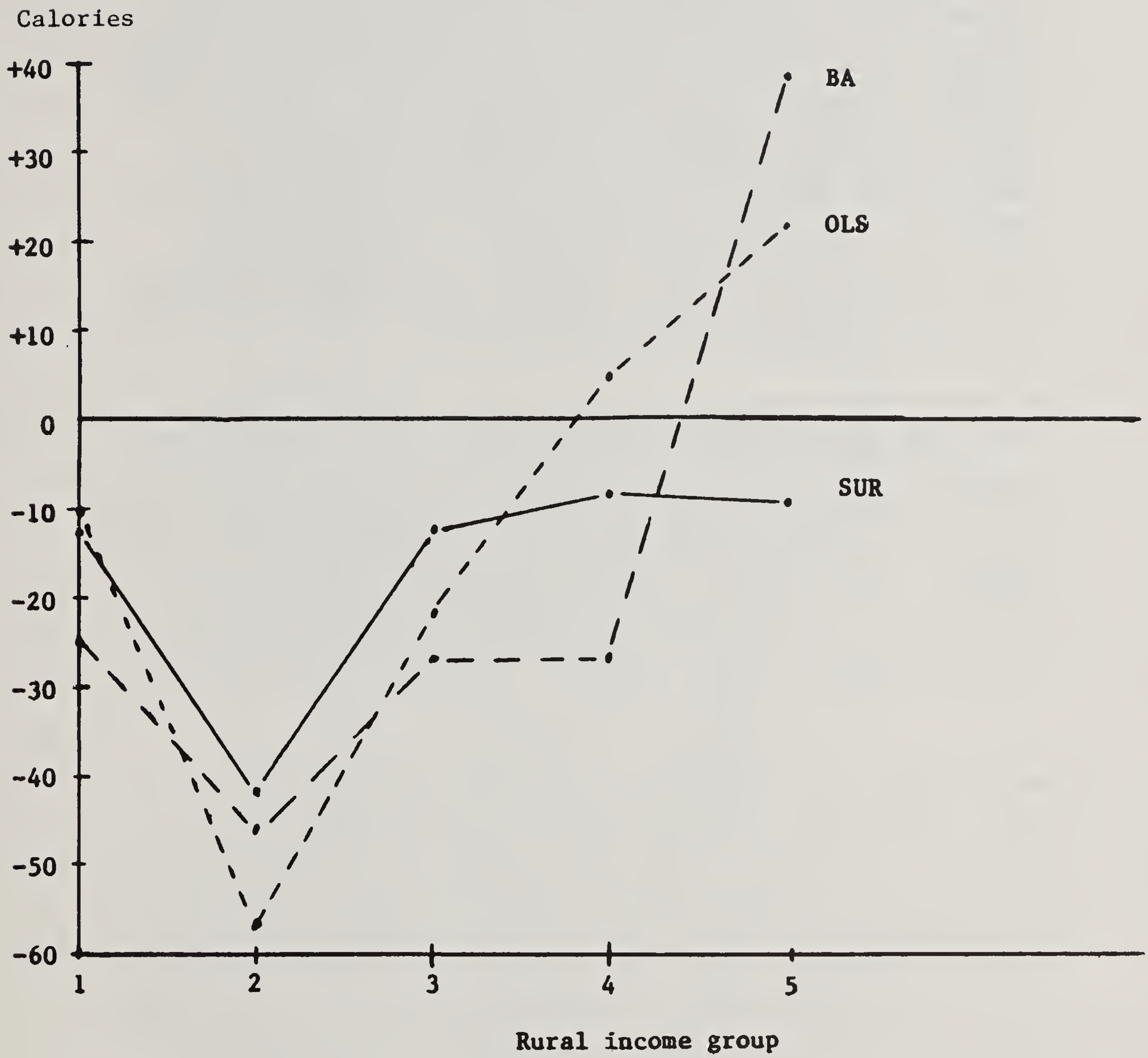


Figure 2: Rural income group: Changes in calories per capita per day as a result of a 5-percent increase in the price of rice



the estimated net caloric change and the substitution among foods provides another source of evidence for making this selection.

Historical and nutritional considerations suggest that a decrease in total caloric consumption due to a 5-percent price increase would be small, particularly in lower income groups. The reasoning is that populations in developing countries have survived price changes in staple foods considerably in excess of 5 percent. For the lower income consumers whose caloric intake is already marginal or below recommended levels, there are two adaptation methods available: (1) reduce activity and hence energy intake requirements, or (2) substitute consumption of other foods to maintain as nearly as possible the prior caloric (energy) intake level. Since a reduction in activity would likely lead to a reduction in personal or family welfare, it seems logical that low-income consumers would substitute foods with high caloric density and similar or lower costs per calorie to partially replace the higher cost staple.

The results show that the estimates of net change in caloric intake from the three procedures are quite small (tables 3 and 4). The decrease in daily per capita caloric intake for urban consumers ranges from -0.2 (OLS estimate for income group 1) to -19.2 (BA estimate for group 3). For rural consumers, the range is from -56.8 (OLS group 2 estimate) to +21.6 (OLS group 5 estimate). When compared against the 1970 recommended level of 2,200 calories per capita per day, the percentages range from negligible to -1.0 percent for urban consumers, and -2.6 percent to +1.0 percent for rural consumers. These values support the historical and nutritional arguments stated above.

The results of the analysis of a 5-percent increase in the market price of rice suggests substitution among foods does occur. The SUR and OLS results support the argument that substitution will be primarily among calorie-dense foods (tables 3 and 4). For example, within urban income group 1 (table 4), the hypothesized 5-percent increase in rice price results in an SUR estimated decrease in rice consumption equivalent to 9.6 calories/capita/day. But, this is virtually offset by increased intake from cereals, fruits and nuts, and sugar for a net change of -1.7 calories/capita/day. The OLS pattern of substitution is similar, while the BA procedure shows almost no substitution. Urban income group 1 has the lowest average per capita daily calorie consumption at only 1,900. Any forced decrease in caloric consumption from one food would likely be made up by increased consumption of other calorie-dense foods, which provide calories at the same or lower cost in order to maintain a minimum physical energy level.9/ This type of substitution is reflected by the SUR and OLS estimates in lower income groups in both rural and urban areas. The substitution effect is only weakly reflected in the BA estimates (see tables 3 and 4).

9/ The cost per 100 calories after substitution has been shown by Yetley and Tun in previous wofk on this data to be down slightly.

Table 3--Change in calories per capita per day resulting from a 5-Percent increase in the price of rice: A comparison of estimates from different procedures for rural income groups

Food group	Rural income group 1			2			3			4			5		
	SUR	BA	OLS	SUR	BA	OLS	SUR	BA	OLS	SUR	BA	OLS	SUR	BA	OLS
	Calories														
Rice	-22.2	-22.0	-16.2	-38.9	-52.3	-44.7	-17.6	-11.1	-18.9	-7.3	-16.3	3.2	-0.8	5.4	22.6
Cereal	4.4	4.3	-0.5	4.5	3.6	-37.3	-4.8	-9.5	-3.4	3.3	-0.5	3.2	-3.4	-5.7	-0.7
Spices	0.1	-1.3	0.5	0.4	-	-1.6	-0.1	-0.6	0.5	-0.8	-0.3	2.3	0.4	1.7	-1.9
Vegetables	0.3	-2.0	1.2	0.3	0.1	3.5	1.0	-1.1	-0.2	-0.8	-0.4	-6.1	4.7	2.4	3.5
Fish	-0.1	-0.7	0.4	0.9	-	-2.0	-0.4	-0.5	-0.2	-0.3	-0.3	-0.4	-0.5	1.9	-1.9
Animal products	-0.6	-0.7	-0.6	-0.2	-	-2.4	-0.2	-0.9	0.6	-	-0.4	0.7	-1.1	3.9	0.4
Fruits and Nuts	2.0	-1.2	3.1	-6.2	0.7	8.5	0.8	-1.0	-5.0	-3.8	-3.7	1.8	-4.4	13.0	5.8
Sugar	4.0	-2.0	2.9	-0.7	1.5	23.2	9.8	-1.3	5.0	2.8	-5.1	1.9	-2.5	15.2	-4.0
Cooking oil	0.1	-	-1.6	-0.8	0.1	-2.3	-	-	0.1	-0.8	-0.1	-0.4	-1.4	0.2	-2.2
ATC	-0.1	0.8	-0.2	-1.0	0.3	-1.7	-0.7	-0.9	-0.4	-0.6	0.2	-0.5	-0.1	0.4	-
NAL	-	-	-	-	-	0.1	-	-	-0.1	-	-	-	-	-	-0.1
Total	-12.1	-24.8	-10.9	-41.7	-46.0	-56.8	-12.2	-26.9	-21.9	-8.3	-26.8	5.6	-8.9	38.4	21.6

Table 4--Change in calories per capita per day resulting from a 5-percent increase in the price of rice: A comparison of estimates from different procedures for urban income groups

Food Group	Urban income group														
	1			2			3			4			5		
	SUR	BA	OLS	SUR	BA	OLS	SUR	BA	OLS	SUR	BA	OLS	SUR	BA	OLS
	Calories														
Rice	-9.6	-18.6	-8.8	-7.1	-14.6	-7.0	-10.3	-6.9	-14.3	-3.4	-2.9	-2.8	-5.9	-2.4	-6.3
Cereal	0.9	5.4	4.3	-2.0	-2.3	-2.6	-1.8	-7.9	-2.0	-3.6	-5.8	-1.6	-1.7	-2.2	-0.4
Spices	-0.4	-0.4	0.3	-0.2	-0.4	-	-0.5	-0.3	0.2	0.4	0.1	2.6	0.7	0.3	1.0
Vegetables	-0.9	-0.4	-1.4	-0.6	-0.4	-0.6	-	-0.3	-1.2	-0.7	0.1	-3.6	0.3	0.4	-0.4
Fish	-0.1	-0.3	0.4	-0.6	-0.3	-0.4	-0.1	-0.2	0.3	0.3	0.1	-0.4	-0.1	0.2	-
Animal products	-0.6	-0.3	-0.6	-0.5	-0.4	-0.4	-0.3	-0.4	-0.6	-0.7	0.2	-0.4	-	0.9	-0.2
Fruits and nuts	4.4	-0.4	1.2	2.8	1.6	2.9	2.3	-1.9	1.6	1.5	-	3.6	-2.7	-1.4	-3.9
Sugar	6.0	-0.7	6.4	6.7	2.3	3.6	5.6	-2.1	1.6	3.3	-	4.2	3.5	-1.7	-0.2
Cooking oil	-0.4	-	-1.1	-0.1	0.1	-0.3	-0.3	-0.1	-0.3	-0.2	-	-0.1	-0.4	-0.1	-0.5
ATC	-0.8	2.2	-0.8	-0.3	-0.2	-0.2	-0.3	0.8	-0.2	-0.2	0.7	-0.1	-0.1	0.6	-0.1
NAL	-	-	-	-	-	0.1	-	-	-0.1	-	-	-	-	-	-
Total	-1.7	-13.6	-0.2	-2.0	-14.6	-5.1	-5.6	-19.2	-14.9	-3.4	-7.4	-7.0	-6.5	-5.2	-10.9

With respect to the expected substitution effect, note that the BA estimates for urban consumers show a larger decrease in caloric intake than either of the other procedures with the exception of group 5, the highest income group (see fig. 1). This is not surprising since the BA procedure does not permit substitution between food blocks. This means that decreased consumption due to a price increase of a food can only be made up by increased consumption of a similar food within the same block, except for the income effect which does permit some consumption changes in other blocks. However, in general, this lack of substitution potential would be expected to result in a larger decrease in the BA estimates when compared to the other procedures. For example, for rural consumers, the BA estimates show a larger decrease than the SUR estimates in all income groups except group 5 (see fig. 2). Since one of the primary reasons for developing the analysis in the detail shown in tables 3 and 4 is to determine which consumer groups within a population are adversely impacted, it does not seem appropriate to use a procedure which does not reflect reasonably expected consumer behavior. For this reason, the validity of the BA procedure for estimating food consumption among low-income groups in developing countries must be suspect.

It is worth noting two points. First, when the calculations indicate substitution occurs between food groups, the associated conversion to nutritional equivalents assumes that, across households within each consumer group, the average change in demand for each specific food will be in the same proportion as its contribution to the food group total. For example, no one food within the vegetable group is allowed to receive all the substitution effect from decreased consumption of rice. Across households, this is probably a fairly good assumption.

However, even for the average across households, this assumption could lead to biased results, especially in lower income groups. Thus, the second point to note involves instances where a specific food may be a cheaper source of calories than a preferred food currently consumed. If poor consumers are forced away from a preferred food by a price rise, they may not spread their substitute purchases over an entire food group. Rather, they may concentrate these purchases on specific foods. In such cases, the assumption used here in the calculation of nutrient intake change would be incorrect. Because of the necessity to aggregate individual foods into groups for statistical estimation purposes, the cheaper, high-caloric food is almost certainly a component within a food group. The assumption that consumption is proportionately spread across the entire group will yield numbers that are smaller in absolute value than the actual changes that occur.

As an example, assume that a price rise for rice causes a substitution for one of the following: millet grains (in the other grains, cereal, and bakery group), sweet potato (in the vegetable group), sugar (in the sugar and confectionary group), or domestic edible oils (in cooking oil, fats, and oil-bearing nuts). If sweet potatoes are a cheaper source of calories, and

poor consumers primarily substitute sweet potatoes for rice, then the "nutrient intake change" calculation use in this paper will give values smaller than the actual.

An interesting income effect may happen when substitution occurs, or is forced to occur, within a food block. Because substitution cannot occur between blocks in the BA procedure, low-income consumers can only substitute millet grains for rice in this study. Assuming that similar amounts of calories are purchased in the form of millet as formerly obtained from rice, this could leave a positive income increment for purchase of other calorie-dense foods. This appears to have happened in BA estimates for the lower income groups (see tables 3 and 4).

The SUR estimates are not without fault. However, on balance, the evidence suggests that SUR estimates have fewer inconsistencies within the overall structure of food demand, as reflected in the matrix of own-price, cross-price, and expenditure elasticities. There is the further consideration of fewer asssumptions (restrictions) about consumer behavior in the SUR as opposed to the BA procedure. When compared to OLS, SUR is statistically superior in the sense of incorporating the theoretical restrictions directly into the estimation procedure. For these reasons, the SUR procedure is judged as the best of the three procedures for estimating the structure of food demand in developing countries using household survey data.

SUMMARY AND CONCLUSIONS

Three procedures, SUR, BA, and OLS, were used to estimate the structure of food demand in a developing country, as reflected by a complete matrix of demand elasticities. A separate matrix was estimated for each consumer group. This paper focused on the validity of the elasticity values, particularly cross-price elasticities. Because of the large number of values, direct comparison was considered infeasible. For this reason, results of the three procedures were compared using the change in consumption of calories resulting from an increase in the price of a staple food.

The three procedures generally estimate similar patterns of net change in consumption across the consumer groups. The estimates are quite close for urban consumers, but considerably less so for rural consumers. When the details of food substitution are studied, however, it becomes apparent that the BA procedure, which is restricted to substituting among foods within the same food block, will generally give a larger, and possibly biased, consumption change estimate. The SUR estimates had fewer inconsistencies than did the OLS values and since SUR is statistically superior to OLS as an estimation technique, it appears to be the best of the three procedures for estimating the structure of food demand from household survey data in developing countries.

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APPENDIX A

Comparison of Own-Price Elasticities from Three Econometric Models

Income strata 1/	Urban Population Econometric Models: Seemingly Unrelated Regression (SUR)	Urban Population Econometric Models: Block Additive (BA)	Urban Population Econometric Models: Ordinary Least Squares (OLS)	Rural Population Econometric Models: Seemingly Unrelated Regression (SUR)	Rural Population Econometric Models: Block Additive (BA)	Rural Population Econometric Models: Ordinary Least Squares (OLS)
	Rice (RCE)					
	-0.43	-0.84	-0.40*	-0.94	-0.93	-0.69
(1)	(0.15)	(0.10)	(0.27)	(0.13)	(0.08)	(0.24)
	-0.31	-0.64	-0.31	-0.70	-0.95	-0.81*
(2)	(0.08)	(0.04)	(0.12)	(0.29)	(0.11)	(0.66)
	-0.43	-0.29	-0.60	-0.51	-0.32	-0.55
(3)	(0.10)	(0.06)	(0.17)	(0.10)	(0.06)	(0.18)
	-0.14*	-0.12*	-0.12*	-0.21*	-0.47	+0.10*
(4)	(0.10)	(0.06)	(0.14)	(0.25)	(0.14)	(0.41)
	-0.23*	-0.09	-0.24*	-0.02*	+0.15*	+0.63*
(5)	(0.13)	(0.04)	(0.18)	(0.28)	(0.09)	(0.52)
	Other Grains, Cereal, and Bakery Products (CER)					
	-0.77	-0.70	-0.83	-0.54	-0.62	-0.55
(1)	(0.08)	(0.08)	(0.09)	(0.09)	(0.08)	(0.10)
	-0.64	-0.63	-0.63	-0.68	-0.67	-0.50
(2)	(0.04)	(0.04)	(0.04)	(0.14)	(0.13)	(0.17)
	-0.41	-0.73	-0.42	-0.26	-0.49	-0.26
(3)	(0.04)	(0.3)	(0.05)	(0.08)	(0.05)	(0.09)
	-0.45	-0.86	-0.25	-0.45	-0.39	-0.34
(4)	(0.04)	(0.02)	(0.06)	(0.09)	(0.10)	(0.10)
	-0.75	-0.97	-0.24	-0.66	-0.95	-0.31
(5)	(0.02)	(0.01)	(0.03)	(0.06)	(0.03)	(0.10)
	Food Consumed Away From Home (FAH)					
	-0.27	-0.44	-0.18	-0.17	-0.23	-0.17*
(1)	(0.06	(0.06)	(0.08)	(0.08)	(0.08)	(0.09)
	-0.19	-0.41	-0.15	-0.25*	-0.16*	+0.03*
(2)	(0.03)	(0.03)	(0.03)	(0.17)	(0.21)	(0.21)
	-0.28	-0.29	-0.23	-0.16	-0.23	-0.15
(3)	(0.05)	(0.04)	(0.05)	(0.07)	(0.07)	(0.07)
	-0.34	-0.33	-0.31	-0.20*	-0.45	-0.16*
(4)	(0.06)	(0.05)	(0.07)	(0.13)	(0.10)	(0.17)
	-0.06*	-0.14	-0.05*	+0.24	+0.05*	+0.41
(5)	(0.06)	(0.05)	(0.06)	(0.11)	(0.12)	(0.16)

Continued--

Comparison of Own-Price Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models: Seemingly Unrelated Regression (SUR)	Urban: Block Addi-tive (BA)	Urban: Ordinary Least Squares (OLS)	Rural Population Econometric Models: Seemingly Unrelated Regression (SUR)	Rural: Block Addi-tive (BA)	Rural: Ordinary Least Squares (OLS)
			Spices (SPI)			
	-0.80	-0.74	-0.83	-0.84	-0.76	-0.90
(1)	(0.05)	(0.06)	(0.06)	(0.05)	(0.04)	(0.05)
	-0.70	-0.71	-0.68	-0.60	-0.73	-0.61
(2)	(0.03)	(0.03)	(0.03)	(0.09)	(0.08)	(0.12)
	-0.67	-0.68	-0.64	-0.68	-0.77	-0.78
(3)	(0.05)	(0.04)	(0.06)	(0.05)	(0.05)	(0.07)
	-0.65	-0.66	-0.66	-0.66	-0.70	-0.36
(4)	(0.06)	(0.06)	(0.08)	(0.11)	(0.10)	(0.16)
	-0.64	-0.60	-0.62	-0.79	-0.80	-0.67
(5)	(0.06)	(0.06)	(0.09)	(0.12)	(0.13)	(0.20)
			Vegetables (VEG)			
	-0.65	-0.84	-0.67	-0.76	-0.87	-0.78
(1)	(0.09)	(0.09)	(0.10)	(0.08)	(0.07)	(0.09)
	-0.74	-0.88	-0.65	-0.70	-0.88	-1.00
(2)	(0.06)	(0.05)	(0.07)	(0.15)	(0.14)	(0.21)
	-0.82	-0.88	-0.80	-0.91	-0.88	-0.97
(3)	(0.07)	(0.06)	(0.08)	(0.08)	(0.07)	(0.10)
	-0.71	-0.84	-0.79	-0.43	-0.54	-0.58
(4)	(0.10)	(0.10)	(0.14)	(0.18)	(0.14)	(0.23)
	-0.67	-0.66	-0.74	-0.41	-0.54	-0.48
(5)	(0.10)	(0.09)	(0.15)	(0.14)	(0.22)	(0.23)
			Fish (FIS)			
	-0.84	-0.90	-0.85	-1.25	-1.28	-1.27
(1)	(0.08)	(0.07)	(0.11)	(0.11)	(0.08)	(0.14)
	-0.79	-0.91	-0.71	-1.03	-1.01	-1.04
(2)	(0.06)	(0.05)	(0.08)	(0.25)	(0.18)	(0.32)
	-0.73	-0.82	-0.69	-0.98	-1.01	-0.84
(3)	(0.08)	(0.07)	(0.10)	(0.12)	(0.10)	(0.15)
	-0.98	-1.16	-1.03	-0.96	-1.06	-1.06
(4)	(0.13)	(0.11)	(0.16)	(0.13)	(0.11)	(0.16)
	-0.66	-0.78	-0.52	-0.73*	-1.37	-0.95*
(5)	(0.10)	(0.09)	(0.14)	(0.39)	(0.27)	(0.50)

Continued--

Comparison of Own-Price Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Addi-tive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Addi-tive (BA)	Ordinary Least Squares (OLS)
	Other Meats (Excluding Fish), Milk, and Eggs (ANI)					
	-0.83	-0.94	-0.77	-0.59	-0.72	-0.52
(1)	(0.13)	(0.10)	(0.14)	(0.12)	(0.10)	(0.14)
	-0.70	-0.82	-0.64	-0.82	-0.98	-0.82*
(2)	(0.06)	(0.05)	(0.07)	(0.29)	(0.26)	(0.47)
	-0.86	-0.98	-0.78	-0.84	-0.93	-0.83
(3)	(0.08)	(0.07)	(0.09)	(0.11)	(0.10)	(0.14)
	-0.64	-1.08	-0.63	-1.25	-1.08	-1.27
(4)	(0.12)	(0.10)	(0.16)	(0.19)	(0.14)	(0.23)
	-0.81	-1.02	-0.85	-1.00	-1.67	-0.98
(5)	(0.11)	(0.08)	(0.15)	(0.27)	(0.20)	(0.46)
	Fruits (FRU)					
	-0.98	-1.04	-1.05	-0.94	-1.01	-1.01
(1)	(0.05)	(0.04)	(0.07)	(0.07)	(0.04)	(0.07)
	-1.05	-0.98	-1.07	-0.61	-0.74	-0.56
(2)	(0.03)	(0.04)	(0.04)	(0.19)	(0.13)	(0.22)
	-1.03	-0.98	-1.13	-0.88	-1.02	-0.86
(3)	(0.04)	(0.03)	(0.05)	(0.06)	(0.04)	(0.07)
	-0.91	-0.96	-1.04	-1.08	-0.96	-1.11
(4)	(0.06)	(0.03)	(0.07)	(0.11)	(0.06)	(0.13)
	-0.82	-0.85	-1.04	-0.74	-1.06	-1.36
(5)	(0.07)	(0.04)	(0.09)	(0.18)	(0.08)	(0.27)
	Sugar and Confectionary (SUG)					
	-1.06	-1.05	-1.04	-1.10	-1.02	-1.09
(1)	(0.04)	(0.03)	(0.05)	(0.03)	(0.02)	(0.04)
	-1.01	-1.00	-1.05	-0.74	-0.83	-0.80
(2)	(0.02)	(0.02)	(0.02)	(0.14)	(0.08)	(0.17)
	-1.02	-1.02	-1.08	-1.03	-0.98	-1.04
(3)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)
	-0.96	-0.99	-1.05	-0.99	-1.04	-1.08
(4)	(0.03)	(0.02)	(0.04)	(0.05)	(0.04)	(0.07)
	-1.07	-1.03	-1.14	-1.21	-0.98	-1.19
(5)	(0.04)	(0.03)	(0.04)	(0.07)	(0.06)	(0.12)

Continued--

Comparison of Own-Price Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)
	Cooking Oils, Fats, and Oil Bearing Nuts (OIL)					
	-0.70	-0.94	-0.75	-1.22	-1.00	-1.10
(1)	(0.11)	(0.09)	(0.13)	(0.23)	(0.15)	(0.29)
	-0.38	-0.63	-0.22	-0.45*	-1.12	-0.87*
(2)	(0.08)	(0.09)	(0.09)	(0.31)	(0.19)	(0.47)
	+0.01*	-0.55	+0.26*	-0.72	-0.85	-0.60
(3)	(0.12)	(0.09)	(0.14)	(0.08)	(0.08)	(0.09)
	-0.78	-0.89	-0.53	+0.59*	-0.64	+0.81
(4)	(0.13)	(0.10)	(0.16)	(0.31)	(0.25)	(0.39)
	+0.11*	-0.56	+0.39	+0.24*	-0.19*	+0.67*
(5)	(0.15)	(0.11)	(0.19)	(0.30)	(0.23)	(0.39)
	Alcohol, Tobacco, and Chewing Nuts (ATC)					
	-0.92	-1.03	-0.91	-0.69	-1.03	-0.66
(1)	(0.06)	(0.01)	(0.08)	(0.06)	(0.01)	(0.08)
	-0.83	-1.02	-0.77	-0.53	-0.97	-0.50
(2)	(0.04)	(0.01)	(0.04)	(0.12)	(0.02)	(0.14)
	-0.58	-1.04	-0.47	-0.49	-1.02	-0.38
(3)	(0.06)	(0.01)	(0.07)	(0.06)	(0.01)	(0.07)
	-0.62	-1.03	-0.48	-0.63	-1.01	-0.50
(4)	(0.09)	(0.01)	(0.12)	(0.12)	(0.02)	(0.15)
	-0.50	-1.06	-0.67	-0.23	-0.93	-0.02*
(5)	(0.09)	(0.01)	(0.11)	(0.10)	(0.03)	(0.15)

Continued--

Comparison of Own-Price Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)
	Nonalcoholic Beverages (NAL)					
	-0.98	-0.86	-1.01	-0.95	-0.79	-0.91
(1)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)
	-0.90	-0.78	-0.87	-0.78	-0.71	-0.88
(2)	(0.02)	(0.02)	(0.02)	(0.07)	(0.06)	(0.09)
	-0.90	-0.76	-0.87	-0.99	-0.72	-0.98
(3)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
	-0.96	-0.77	-0.91	-0.93	-0.74	-0.95
(4)	(0.04)	(0.04)	(0.05)	(0.08)	(0.08)	(0.10)
	-0.86	-0.81	-0.84	-0.78	-0.51	-0.87
(5)	(0.04)	(0.04)	(0.05)	(0.10)	(0.10)	(0.18)

1/ Household monthly income strata are: (1) under 200 Rs; (2) 200-399 Rs; (3) 400-599 Rs; (4) 600-799 Rs; and (5) over 799 Rs.

* Estimated coefficient is not significantly different from zero at the 5-percent level.

Source: Reproduced from Chieruzzi, Morgan, and Yetley (see References).

APPENDIX B

Comparison of Income Elasticities from Three Econometric Models

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)
	Rice (RCE)					
	1.02	1.21	0.82	1.11	1.25	1.06
(1)	(0.12)	(0.09)	(0.12)	(0.09)	(0.06)	(0.10)
	0.92	1.07	0.74	1.31	1.20	1.20
(2)	(0.06)	(0.04)	(0.06)	(0.16)	(0.07)	(0.27)
	1.05	0.77	0.65	1.04	0.80	0.64
(3)	(0.08)	(0.06)	(0.08)	(0.09)	(0.07)	(0.10)
	0.62	0.55	0.58	0.87	0.86	0.64
(4)	(0.12)	(0.10)	(0.12)	(0.18)	(0.14)	(0.20)
	0.29	0.28	0.19	0.38	0.15*	0.51
(5)	(0.09)	(0.08)	(0.08)	(0.15)	(0.13)	(0.14)
	Other Grains, Cereal, and Bakery Products (CER)					
	0 57	0.62	0.53	0.52	0.57	0.47
(1)	(0.13)	(0.11)	(0.13)	(0.10)	(0.08)	(0.10)
	0.63	0.84	0.49	0.59	0.59	0.60
(2)	(0.06)	(0.05)	(0.06)	(0.19)	(0.13)	(0.25)
	0.98	1.13	0.69	0.91	1.07	0.29
(3)	(0.07)	(0.03)	(0.08)	(0.12)	(0.06)	(0.13)
	1.29	1.15	0.64	0.67	0.51	0.65
(4)	(0.07)	(0.03)	(0.10)	(0.18)	(0.14)	(0.17)
	1.27	1.10	0.52	1.34	1.25	0.32*
(5)	(0.04)	(0.01)	(0.07)	(0.13)	(0.05)	(0.23)
	Food Consumed Away From Home (FAH)					
	0.88	1.08	0.75	0.91	1.05	0.80
(1)	(0.14)	(0.11)	(0.16)	(0.14)	(0.12)	(0.16)
	1.04	1.08	0.97	0.67	0.68	1.12
(2)	(0.07)	(0.06)	(0.07)	(0.26)	(0.25)	(0.36)
	0.97	0.90	0.76	1.11	1.25	0.86
(3)	(0.10)	(0.08)	(0.10)	(0.16)	(0.13)	(0.16)
	0.79	0.76	0.61	1.34	1.95	0.79
(4)	(0.14)	(0.11)	(0.13)	(0.33)	(0.19)	(0.35)
	0.34	0.43	0.27	0.76	0.47*	0.43*
(5)	(0.11)	(0.10)	(0.10)	(0.24)	(0.26)	(0.29)

Continued--

Comparison of Income Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)
			Spices (SPI)			
(1)	0.95 (0.07)	0.94 (0.07)	0.81 (0.07)	0.97 (0.06)	0.89 (0.05)	0.97 (0.06)
(2)	0.91 (0.03)	0.86 (0.03)	0.79 (0.03)	0.89 (0.08)	0.93 (0.07)	0.97 (0.10)
(3)	0.97 (0.04)	0.91 (0.04)	0.70 (0.05)	0.73 (0.06)	0.75 (0.04)	0.59 (0.06)
(4)	0.68 (0.07)	0.82 (0.06)	0.44 (0.07)	0.91 (0.12)	0.85 (0.09)	0.73 (0.11)
(5)	0.47 (0.06)	0.69 (0.06)	0.30 (0.05)	0.75 (0.12)	0.69 (0.15)	0.38 (0.14)
			Vegetables (VEG)			
(1)	0.77 (0.09)	0.79 (0.08)	0.64 (0.09)	1.02 (0.07)	0.91 (0.06)	0.95 (0.08)
(2)	0.72 (0.05)	0.75 (0.04)	0.63 (0.04)	0.86 (0.11)	0.96 (0.09)	0.94 (0.14)
(3)	0.72 (0.05)	0.73 (0.05)	0.56 (0.05)	0.81 (0.07)	0.79 (0.05)	0.58 (0.07)
(4)	0.68 (0.08)	0.77 (0.07)	0.54 (0.07)	0.61 (0.13)	0.68 (0.10)	0.53 (0.12)
(5)	0.52 (0.06)	0.69 (0.06)	0.31 (0.05)	0.56 (0.10)	0.57 (0.12)	0.39 (0.09)
			Fish (FIS)			
(1)	1.06 (0.11)	1.03 (0.09)	0.95 (0.12)	1.29 (0.10)	1.20 (0.07)	1.16 (0.11)
(2)	1.14 (0.05)	1.02 (0.05)	0.96 (0.06)	0.88 (0.19)	0.88 (0.15)	1.07 (0.26)
(3)	0.80 (0.07)	0.87 (0.06)	0.56 (0.07)	1.21 (0.11)	0.98 (0.08)	0.78 (0.11)
(4)	0.73 (0.11)	0.95 (0.10)	0.60 (0.10)	1.12 (0.14)	1.02 (0.12)	0.96 (0.13)
(5)	0.54 (0.09)	0.80 (0.09)	0.38 (0.08)	0.76 (0.25)	1.11 (0.23)	0.71 (0.26)

Continued--

Comparison of Income Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models: Seemingly Unrelated Regression (SUR)	Urban: Block Additive (BA)	Urban: Ordinary Least Squares (OLS)	Rural Population Econometric Models: Seemingly Unrelated Regression (SUR)	Rural: Block Additive (BA)	Rural: Ordinary Least Squares (OLS)
	Other Meats (Excluding Fish), Milk, and Eggs (ANI)					
	0.90	1.20	0.83	0.91	1.00	0.88
(1)	(0.15)	(0.11)	(0.14)	(0.13)	(0.10)	(0.15)
	1.17	1.32	0.96	1.25	1.27	1.37
(2)	(0.08)	(0.06)	(0.08)	(0.26)	(0.19)	(0.37)
	1.27	1.41	0.92	1.36	1.44	1.02
(3)	(0.08)	(0.07)	(0.08)	(0.14)	(0.09)	(0.14)
	1.15	1.31	0.64	1.37	1.30	0.77
(4)	(0.12)	(0.10)	(0.13)	(0.21)	(0.13)	(0.21)
	0.92	1.43	0.57	1.10	1.34	0.77
(5)	(0.10)	(0.07)	(0.09)	(0.23)	(0.18)	(0.24)
	Fruits (FRU)					
	0.85	1.01	0.74	0.83	0.95	0.74
(1)	(0.07)	(0.04)	(0.07)	(0.07)	(0.04)	(0.08)
	0.85	0.76	0.71	0.99	0.84	1.21
(2)	(0.04)	(0.04)	(0.04)	(0.24)	(0.15)	(0.30)
	0.94	1.08	0.69	0.94	1.11	0.74
(3)	(0.05)	(0.03)	(0.05)	(0.09)	(0.03)	(0.09)
	0.72	1.06	0.54	0.89	1.07	0.67
(4)	(0.07)	(0.04)	(0.07)	(0.13)	(0.06)	(0.13)
	0.71	1.08	0.37	0.59	1.18	0.51
(5)	(0.07)	(0.04)	(0.07)	(0.22)	(0.08)	(0.22)
	Sugar and Confectionary (SUG)					
	0.66	1.01	0.62	0.83	1.07	0.83
(1)	(0.09)	(0.04)	(0.09)	(0.07)	(0.04)	(0.07)
	0.71	0.69	0.59	0.92	1.10	0.63
(2)	(0.04)	(0.04)	(0.04)	(0.22)	(0.12)	(0.29)
	0.68	0.90	0.48	0.64	0.91	0.49
(3)	(0.05)	(0.02)	(0.05)	(0.07)	(0.03)	(0.07)
	0.46	0.91	0.33	0.89	0.97	0.57
(4)	(0.07)	(0.04)	(0.07)	(0.13)	(0.06)	(0.14)
	0.46	0.94	0.29	0.86	0.94	0.24*
(5)	(0.08)	(0.04)	(0.07)	(0.15)	(0.10)	(0.19)

Continued--

Comparison of Income Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Additive (BA)	Ordinary Least Squares (OLS)
	Cooking Oils, Fats, and Oil Bearing Nuts (OIL)					
(1)	1.24 (0.12)	0.92 (0.08)	1.02 (0.12)	1.13 (0.11)	0.93 (0.10)	1.11 (0.11)
(2)	0.97 (0.07)	0.67 (0.06)	0.85 (0.06)	1.00 (0.17)	1.09 (0.15)	1.12 (0.21)
(3)	1.15 (0.09)	1.04 (0.07)	0.83 (0.09)	1.11 (0.14)	0.94 (0.09)	0.87 (0.14)
(4)	1.03 (0.14)	1.08 (0.10)	0.56 (0.13)	1.28 (0.24)	0.86 (0.18)	1.02 (0.20)
(5)	0.71 (0.10)	0.94 (0.08)	0.50 (0.09)	0.62 (0.22)	0.55 (0.15)	0.42* (0.20)
	Alcohol, Tobacco, and Chewing Nuts (ATC)					
(1)	1.90 (0.13)	1.06 (0.01)	1.51 (0.15)	1.37 (0.11)	1.07 (0.01)	1.15 (0.13)
(2)	1.70 (0.08)	1.07 (0.01)	1.28 (0.09)	0.94 (0.18)	1.02 (0.02)	1.03 (0.22)
(3)	1.38 (0.11)	1.09 (0.01)	0.70 (0.13)	1.16 (0.14)	1.08 (0.01)	0.60 (0.15)
(4)	1.45 (0.19)	1.08 (0.01)	0.23* (0.20)	1.12 (0.29)	1.07 (0.02)	0.49* (0.32)
(5)	1.31 (0.17)	1.11 (0.01)	0.52 (0.16)	1.03 (0.27)	1.05 (0.03)	0.52* (0.29)

Continued--

Comparison of Income Elasticities from Three Econometric Models--Con't.

Income strata 1/	Urban Population Econometric Models			Rural Population Econometric Models		
	Seemingly Unrelated Regression (SUR)	Block Addi-tive (BA)	Ordinary Least Squares (OLS)	Seemingly Unrelated Regression (SUR)	Block Addi-tive (BA)	Ordinary Least Squares (OLS)
	Nonalcoholic Beverages (NAL)					
	1.02	0.70	0.88	0.97	0.64	0.98
(1)	(0.10)	(0.04)	(0.10)	(0.09)	(0.05)	(0.09)
	1.06	0.67	0.91	1.05	0.89	0.95
(2)	(0.06)	(0.03)	(0.06)	(0.16)	(0.10)	(0.19)
	1.01	0.58	0.68	0.73	0.58	0.59
(3)	(0.08)	(0.04)	(0.08)	(0.10)	(0.05)	(0.10)
	0.84	0.61	0.63	1.27	0.68	0.87
(4)	(0.12)	(0.05)	(0.11)	(0.21)	(0.09)	(0.20)
	0.62	0.57	0.50	0.90	0.78	0.74
(5)	(0.12)	(0.05)	(0.11)	(0.24)	(0.11)	(0.26)

1/ Household monthly income by strata are: (1) Under 200 Rs; (2) 200-399 Rs; (3) 400-599 Rs; (4) 600-799 Rs; and (5) Over 799 Rs.

* Estimated coefficient is not significantly different from zero at the 5-percent level.

Source: Reproduced from Chieruzzi, Morgan, and Yetley (see References).